

**REMARKS**

***Overview***

In the Office Action under reply, claims 1-43 were examined. The claims stand rejected as follows:

- (1) claims 1-43 are rejected under 35 U.S.C. §112, first paragraph (written description);
- (2) claims 1-43 are rejected under 35 U.S.C. §112, first paragraph (enablement);
- (3) claims 1-43 are rejected under 35 U.S.C. §112, second paragraph (indefinite);
- (4) claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by Basu, US 4,423,125 ("the '125 patent");
- (5) claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by Basu, US 4,304,825 ("the '825 patent");
- (6) claims 1-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by Mayer et al., US 5,358,802 ("the '802 patent");
- (7) claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by Diederich, Covalent Fullerene Chemistry, (1997), *Pure & Appl. Chem.*, 69(3):395-400 ("Diederich");
- (8) claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over the '125 patent;
- (9) claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over the '825 patent;
- (10) claims 1-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over the '802 patent;
- (11) claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Diederich;
- (12) claims 1-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Applicants' admissions;
- (13) claims 1-43 are rejected under 35 U.S.C. §103(a) as obvious over Applicants' admissions;
- (14) claims 1-25 and 27-43 are rejected under 35 U.S.C. §103(a) as unpatentable over Rodriguez, US 5,653,951 ("Rodriguez") in view of Inagaki et al., (2001) *Determining Factors*

*for the Intercalation into Carbon Materials from Organic Solutions*, 39 Carbon 1083 ("Inagaki"); and

(15) claim 26 is rejected under 35 U.S.C. §103(a) as unpatentable over Rodriguez in view of Inagaki, and further in view of Janot et al. (2001), *Ball Milling: a new route for the synthesis of superdense lithium GICs*, 39 Carbon 1931 ("Janot").

The rejections and objections are overcome in part by the amendments made herein, and are otherwise traversed for at least the reasons set forth below.

### ***Claim amendments***

With the amendments made herein, claims 1-16, 18, 21-25, and 37-43 are canceled.

Claim 17 has been amended to recite that the organic ligands have unsaturated groups. Support for this amendment can be found, for example, in paragraph [00041] of the original disclosure. Claim 17 has been further amended to specify that the carbon material is a plurality of graphene sheets. This amendment is supported, for example, by paragraphs [00028], [00033], and [00054] of the original disclosure. Claim 17 has been further amended to specify that the reaction is a Diels-Alder reaction, and the reaction is between unsaturated groups in the organic ligands and the graphene sheets. Support for this amendment can be found, for example, in paragraph [00041] of the original disclosure. Claim 17 has been further amended to specify that the Diels-Alder reaction forms graphene sheets covalently bonded to the organic ligands and having an interlayer distance of between 6 Å and 12 Å. Support for this amendment can be found, for example, in paragraphs [00035] and [00045] of the original disclosure. No new matter is added by these amendments.

Claim 23 has been amended to remove the term "cation." This amendment is made so that the claim has proper antecedent basis.

Claims 26 and 29-31 have been amended to conform to the amendments made to claim 17.

Claim 34 has been amended to update the dependency, in light of the cancellation of claim 33.

Claim 36 has been amended to remove the term "pillared." Claim 36 has been further amended to specify that the carbon material parts are graphene sheets. Support for this amendment is found, for example, in paragraphs [00028], [00033], and [00054] of the original

disclosure, as well as original claim 37. Claim 36 has been further amended to specify that the graphene sheets are separated from each other by metal cations. Support for this amendment is found, for example, in paragraph [00040] of the original specification. Claim 36 has been further amended to specify that the metal cations are solvated by organic ligands. Support for this amendment is found, for example, in paragraph [00039] of the original specification. Claim 36 has been further amended to specify that the organic ligands are covalently attached to the graphene sheets. Support for this amendment can be found, for example, in paragraph [00045] of the original specification.

These amendments are made without prejudice and solely for the purpose of speeding prosecution. Applicants reserve the right to submit claims directed to canceled subsection matter in one or more continuation applications.

***Rejection under 35 U.S.C. §112, 1st paragraph***

Claims 1-43 are rejected under 35 U.S.C. §112, first paragraph, for failing to comply with the written description requirement. This rejection is overcome and traversed.

The pending claims are directed to a method for making a carbon-based hydrogen storage composition, or an improved method of making a hydrogen storage device. The term "pillar" does not appear in any of the pending claims. Accordingly, the comments that appear on pages 6-9 of the Action are not relevant to the pending claims.

Furthermore, regarding the comments on page 10 of the Action, applicants note that the methods of the pending claims are described using art-recognized terms and/or terms that are expressly defined in the specification. Certainly, there would be no doubt to a skilled artisan what is meant by an "alkali metal," or a "Diels-Alder reaction," etc. The specification provides sufficient written description for each term in the claims, as well as for the claims read in their entirety. Accordingly, applicants respectfully request withdrawal of the rejection.

***Rejection under 35 U.S.C. §112, 1st paragraph***

Claims 1-43 are rejected under 35 U.S.C. §112, first paragraph, for failing to comply with the enablement requirement. This rejection is overcome and traversed.

The pending claims are not indefinite (see discussion below), and the disclosure provided in the original specification is sufficient to enable the skilled artisan to practice the claimed

methods. This becomes apparent if one considers each step recited in claim 17. First, *providing* a solvated alkali metal containing organic ligands having unsaturated groups is certainly within the skill in the art. This is true particularly since the specification provides examples of suitable metals and organic ligands. Next, *combining* the solvated alkali metal containing organic ligands with a plurality of graphene sheets to form a plurality of carbene sheets co-intercalated with alkali metal cations containing organic ligands is also within the capabilities of the skilled artisan. Next, *carrying out* a Diels-Alder reaction between the unsaturated groups of the organic ligands and the graphene sheets is also within the capabilities of the skilled artisan. As mentioned previously by applicants, the Diels-Alder reaction is a type of reaction that has been known for many years, and the skilled artisan could conduct such a reaction given a diene and a dienophile as reactants. Finally, *doping* the graphene sheets with a metal is a process step that is well within the skill in the art, particularly in light of the disclosure. In summary, the methods of the instant claims are fully enabled given the instant disclosure and the knowledge common in the art.

The Action states that a Diels-Alder type reaction is indefinite. This is, in fact, not so. Use of the term "type" in association with a named chemical reaction is exceedingly common in the chemical arts, and does not introduce any ambiguity for the skilled artisan. Indeed, Google Scholar lists over 400 uses of the term "Diels Alder type reaction" (see attachment 1). The term indicates to the skilled artisan that the reaction under consideration is the type of reaction that is associated with the name "Diels Alder." Use of the term "type" is, in fact, a technically proper way to refer generally to a named reaction. For example, the name "Diels Alder" applies not to a single reaction, but to a large number of reactions that involve dienes and dienophiles of various structures. The skilled artisan would understand that both terms, "Diels-Alder type reaction" and "Diels-Alder reaction," refer to exactly the same set of reactions.

In light of the foregoing, applicants respectfully request withdrawal of the rejection.

### ***Rejection under 35 U.S.C. §112, 2<sup>nd</sup> paragraph***

Claims 1-43 stand rejected under 35 U.S.C. §112, second paragraph, as "indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention" (Action at page 14).

In light of the amendments made herein, this rejection is moot. Applicants respectfully request withdrawal of the rejection.

***Rejection under 35 U.S.C. §102***

Claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by the '125 patent. This rejection is moot, as claims 1-6, 8-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102***

Claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by the '825 patent. This rejection is moot, as claims 1-6, 8-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102***

Claims 1-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by the '802 patent. This rejection is moot, as claims 1-16 and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102***

Claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102 as anticipated by Diederich. This rejection is moot, as claims 1-6, 8-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102/103***

Claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over the '125 patent. This rejection is moot, as claims 1-6, 8-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102/103***

Claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over the '825 patent. This rejection is moot, as claims 1-6, 8-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102/103***

Claims 1-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over the '802 patent. This rejection is moot, as claims 1-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102/103***

Claims 1-6, 8-16, and 37-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Diederich. This rejection is moot, as claims 1-6, 8-16, and 37-43 have been canceled.

***Rejection under 35 U.S.C. §102/103***

Claims 1-43 are rejected under 35 U.S.C. §102(b) as anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Applicants' admissions. This rejection is traversed.

The Action mischaracterizes statements made in applicants response dated May 23, 2007 ("the May 23 response"). The Action provides, *inter alia*, the following quote from the May 23 response:

In general, therefore, each of the steps required to prepare compositions according to the claims are well known and understood in the art. Even if the preparation of an optimized composition would require optimization of the reaction conditions in one or more of the above-described steps, the preparation of any composition according to the claims is immediately practicable by the skilled artisan based on the disclosure of the application.

(Action at 20, emphases added in Action). The Action states that "[t]he Examiner is interpreting the part where Applicants stated on and for the record that 'each of the steps required to prepare compositions according to the claims are well known and understood in the art' to mean that 'each of the steps required to prepare compositions according to the claims are well known and understood in the art'" (Action at 20). This interpretation, however, takes applicants' statements out of context.

The sentence being interpreted by the Examiner begins with the words "[i]n general, therefore," and the sentence is preceded in applicants' Remarks of May 23, 2007 by a lengthy discussion of a three-step process described in the specification. Those three steps are: (1) an intercalation reaction; (2) a Diels-Alder reaction; and (3) an intercalation and milling process. It is these three steps, in general, that are known in the art. In other words, intercalation reactions, Diels-Alder reactions, and milling processes in general are known in the art. Applicants' statements do not imply that the overall process of the pending claims (i.e., the combination of these three steps in the manner required according to the claims) is well known in the art.

Even if, *arguendo*, applicants' statements were interpreted to mean that applicants believed their claimed process was known in the art, such a statement would be applicable only to the claims as they were pending at the time of the statements. In light of the amendments to the claims, applicants statements may no longer be (even mistakenly) interpreted as indicating that the present claims were known in the art.

For at least the foregoing reasons, applicants respectfully request withdrawal of the rejection.

***Rejection under 35 U.S.C. §103(a)***

Claims 1-43 are rejected under 35 U.S.C. §103(a) as obvious over Applicants' admissions. This rejection is traversed.

The preceding discussion of applicants' admissions is expressly incorporated herein by reference. Furthermore, with respect to the pending method claims, the origin and utility of computer simulations is not relevant. The claimed methods do not include method steps that involve computer simulations.

Applicants respectfully request withdrawal of the rejection.

***Rejection under 35 U.S.C. §103(a)***

Claims 1-25 and 27-43 are rejected under 35 U.S.C. §103(a) as unpatentable over Rodriguez in view of Inagaki.

The Examiner cites Rodriguez as describing layered carbon compositions, and Inagaki as describing the intercalation of carbon materials with an organic ligand (Action at page 11). Neither Inagaki nor Rodriguez teaches carrying out a reaction between unsaturated groups of organic ligands and graphene sheets to form graphene sheets covalently bonded to the organic ligands and having an interlayer distance of between 6 Å and 12 Å, as required by claim 17. In fact, neither reference suggests anything other than simple intercalation of metals into carbon materials. The skilled artisan would have no reason to modify the materials and methods of Rodriguez by performing a reaction between organic ligands and graphene sheets.

The MPEP provides the standard for a rejection based on obviousness: "[w]ith regard to rejections under 35 U.S.C. 103, the examiner must provide evidence which as a whole shows that the legal determination sought to be proved (i.e., the reference teachings establish a *prima*

*facie* case of obviousness) is more probable than not." (MPEP § 2142.) The Action fails to meet this standard. As shown by the arguments set forth above, the bulk of the evidence suggests that there is no *prima facie* case of obviousness of the claimed methods over the references.

Accordingly, the teachings of the references, alone or in combination, do not render the instant claims obvious. Applicants respectfully request withdrawal of the rejection.

#### ***Rejection under 35 U.S.C. §103(a)***

Claim 26 is rejected under 35 U.S.C. §103(a) as unpatentable over Rodriguez in view of Inagaki, and further in view of Janot.

The Examiner states that Rodriguez does not disclose ball milling, but that Janot provides the missing teaching. Regardless of whether Janot teaches ball milling, however, the combination of Rodriguez in view of Inagaki does not teach the claimed methods (see discussion above). In particular, neither Rodriguez nor Inagaki teach carrying out a reaction between a graphene sheets and organic ligands intercalated therein. Janot also does not teach carrying out a reaction between a carbon material and organic ligands intercalated therein. Accordingly, Janot does not provide the teachings missing from the combination of Rodriguez and Inagaki. Applicants respectfully request withdrawal of the rejection.

#### ***Examiner's Request for Information***

The Examiner has requested the results of any searches that applicants have made, and refers to applicants' remarks of 2/19/08, p. 9. The referenced search consisted of applicants typing the keywords "Diels Alder" into the search field of the USPTO Patent Full-Text and Image Database (available online at <http://patft.uspto.gov/netahtml/PTO/search-adv.htm>). As of 9/10/08, this same search returns 5,327 US patent references. Applicants are happy to report the results of this search, for example in an Information Disclosure Statement; in consideration of the large number of references, however, applicants would appreciate confirmation from the Examiner that such a reporting is desired.



**CONCLUSION**

Applicants submit that the claims of the application are in condition for allowance. Applicants respectfully request withdrawal of the rejections, and prompt issuance of a notice of allowance. If the Examiner has any questions concerning this communication, or would like to discuss the application, the art, or other pertinent matters, a telephone call to the undersigned would be welcomed.

Respectfully submitted,

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## **Attachment 1**

Results 1-10 from a Google Scholar search for keywords "diels alder type reaction"  
conducted on September 10, 2008



[Web](#) [Images](#) [Video](#) [News](#) [Maps](#) [more »](#)

"diels alder type reaction"

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**Scholar** All articles - **Recent articles** Results 1 - 10 of about 443 for "**diels alder type reaction**". (0.)

**Strained Cyclic Cumulene Intermediates in Diels-Alder Cycloadditions of Enynes and Diynes**

RC Burrell, KJ Daoust, AZ Bradley, KJ DiRico, RP ... - JOURNAL-AMERICAN CHEMICAL SOCIETY, 1996 - pubs.acs.org

... Our experimental results include the first **Diels-Alder type reaction** in which a 1,3-diyne acts as the four-electron component, with apparent generation of an ...

Cited by 14 - [Related articles](#) - [Web Search](#) - [BL Direct](#) - All 4 versions

**On Inventing Reactions for Atom Economy**

BM Trost - ACCOUNTS OF CHEMICAL RESEARCH, 2002 - webhost.bridgew.edu

... The ability to generate such a complex tricycle by this unprecedented bis-homo-**Diels-Alder-type reaction** becomes even more impressive as an atom-economical ...

Cited by 75 - [Related articles](#) - [View as HTML](#) - [Web Search](#) - [BL Direct](#) - All 5 versions

**Composition of oils derived from the batch pyrolysis of tyres - Find It @ FLCC**

AM Cunliffe, PT Williams - Journal of Analytical and Applied Pyrolysis, 1998 - Elsevier

... 8] and Kaminsky and Sinn [5]. A **Diels-Alder type reaction** mechanism as discussed below was suggested as the cause of this increase in aromatisation [13, 28]. ...

Cited by 79 - [Related articles](#) - [Web Search](#) - All 2 versions

**Diels-Alder reactions on solid supports - Find It @ FLCC**

J Yli-Kaunhaluoma - Tetrahedron, 2001 - Elsevier

User Name: Password: Remember me on this computer, Forgotten password? ...

Cited by 10 - [Related articles](#) - [Web Search](#) - [BL Direct](#) - All 2 versions

**Ticlodipine as a selective mechanism-based inhibitor of human cytochrome P450 2C19**

- Find It @ FLCC

NT Ha-Duong, S Dijols, AC Macherey, JA Goldstein, ... - Biochemistry, 2001 - depts.washington.edu

Page 1. Ticlodipine as a Selective Mechanism-Based Inhibitor of Human Cytochrome P450 2C19 † Nguy  t-Thanh Ha-Duong, ‡ Sylvie ...

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**Heat-resistant resins derived from cyano-substituted Diels-Alder polymers**

CD DIAKOUMAKOS, JA MIKROYANNIDIS - European polymer journal, 1994 - cat.inist.fr

... furan terminal groups and cyano pendant groups were synthesized and polymerized with 4, 4'-bismaleimidediphenylmethane(BMDM) through a **Diels-Alder type reaction** ...

Cited by 4 - [Related articles](#) - [Web Search](#) - [Find It @ FLCC](#) - [BL Direct](#)

**Chemistry and biosynthesis of prenylflavonoids - Find It @ FLCC**

T Nomura - Yakugaku Zasshi, 2001 - grande.nai.usda.gov

... Chalconoracine (28) and kuwanon J (28) were proved to be enzymatic **Diels-Alder type reaction** products by the administration experiment with O-methylchalcone ...

Cited by 4 - [Related articles](#) - [Cached](#) - [Web Search](#) - [BL Direct](#) - All 3 versions

**Kinetic study of model reactions in the gas phase at the early stage of coke formation**

D Nohara, T Sakai - Industrial & Engineering Chemistry Research, 1992 - pubs.acs.org

... hydrocarbons at relatively low temperatures (-600 °C), ie, through a **Diels-Alder type reaction**. On the other hand, such growth of ring ...

Cited by 10 - Related articles - Web Search - Find It @ FLCC - All 3 versions

**Dimeric xanthenes from *Garcinia livingstonei***

I SORDAT-DISERENS, M HAMBURGER, C ROGERS, K ... - Phytochemistry, 1992 - cat.inist.fr  
... to 1, 4, 5-trihydroxy-3-(3-methylbut-2-enyl)-9 H-xanthen-9-one and formally derive  
from the corresponding diene via dimerization by a **Diels-Alder-type reaction**. ...

Cited by 8 - Related articles - Web Search - Find It @ FLCC - All 3 versions

**An FT-IR study on Diels-Alder reactions catalysed by heteropoly acid containing sol-gel silica**  
- Find It @ FLCC

Á Kukovec, Z Kónya, I Kiricsi - Journal of Molecular Structure, 2001 - Elsevier  
... from each other. It is visible in Scheme 1 (**Diels-Alder type reaction** between  
1,3-cyclohexadiene and 2-propenal. I: 1,3-cyclohexadiene ...

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Key authors: **P. Williams** - **A. Cunliffe** - **B. Trost** - **K. Yoon** - **N. Ha-Duong**

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